

## SAFETY OF RAILWAY SYSTEM

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*Summary: Some safety system is the problem of our age. The article deals with the safety of the railway system. It presents the basic elements and components safety of the railway system. The main thrust of the article is risk and its acceptability in the railway system. The article is focused on characteristics of causes of railway system safety, which are identified by the method - Ishikawa diagram.*

*Key words: safety, railway system, risk.*

### INTRODUCTION

Safety is defined as a property of a system which does not in any way endanger neither persons nor its environment. Another definition is a removal of unacceptable risk. Railway system is a system affected by various stochastic influences. These are i.e. human errors, unforeseen failures, and different combinations of unfavorable situations which may negatively influence the safety of various elements or even of the whole railway system.

Since there is no such thing as zero risk, it is not possible to reach an absolute safety. To recognize potential danger it is necessary to isolate all potential sources of danger. This can be done using a proper method.

### 1. SAFETY ELEMENTS

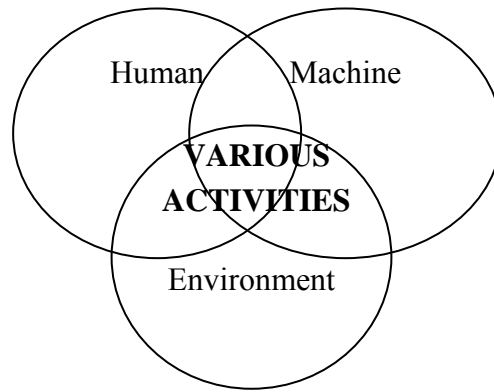
Safety of a railway system is dependent on the balance of following three elements: “man – machine – environment”. Neglecting one of the elements may cause a system imbalance as result of negative externality and thus interrupt the operation execution.

The goal of optimization of ergatic systems (man machine systems) is to ensure well-being of humans and prevent any injuries caused by accidents. An ergatic system is shown on figure 1.

Many see a human in railway system only as train driver. However, railway system includes all persons directly connected to the operation of rail vehicle. This includes other railway employees (train dispatchers, transitters and others) and all people influencing the railway system.

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Source: (2)

Fig. 1 – Ergatic System

The term “Machine” means railway vehicle which may under certain circumstances disrupt the functionality of the railway system. The circumstances may be i.e. bad technical condition, derailling of the vehicle and others.

Environment is another element of railway system, which directly influences safety of the system. Railway vehicle exists in certain environment in which other necessary machines and devices are used, and various activities are performed.

## 2. LEGAL ENVIRONMENT

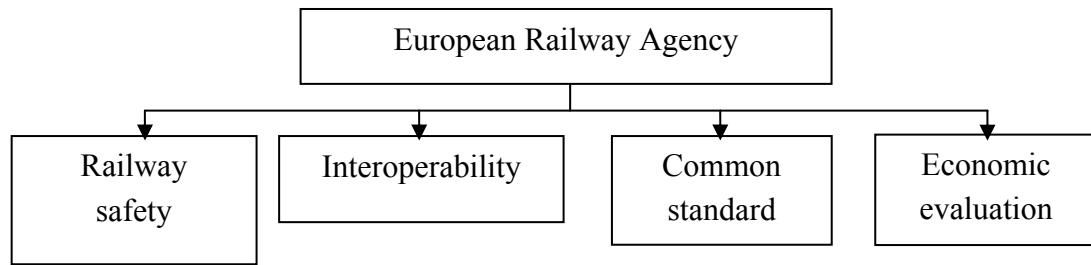
Slovak republic has passed several legal bills regarding the railway system safety after its integration into the European Union. The directive 2004/49/ES has introduced a railway safety, which is a new competence of the European Union.

Interoperability is closely related to the railway safety. Interoperability mirrors the ability of the existing railway system to provide for safe and undisturbed movement of trains reaching the level of performance required by the railway system. It is defined according to the directive regarding the interoperability of railway systems nr. 2008/57/ES. Safety requirements are regarded in the legal bill nr. 513/2009 of railways. It defines a minimum safety level expressed via acceptable risk level. This defined minimum safety has to be reached by all elements of railway system.

It is necessary to create an integrated railway space which will also concern the railway safety, because there are various problems regarding common solutions.

As a most suitable tool, the European Railway Agency has been found in year 2004. It resides in the French city of Valenciennes.

It represents an important part in the politics of modernization of European railway sector. The agency is concerned by implementation of various agendas such as railway safety, interoperability, common standards for European railways and economic evaluation. These are shown in the figure 2.



Source: (3)

Fig. 2 – Agenda of the European Railway Agency

The agenda of common standards regards introduction of common signaling standards in railway transport within the whole EU. The main obstacles in railway development are incompatible technical and safety standards within the member countries. The main goal of the European Railway Agency is a step by step harmonization of those incompatible standards. Last, but not least is an implementation of common safety goals and methodic for the whole European railway system.

### 3. COMPONENTS OF THE RAILWAY SAFETY SYSTEM

Safety of a railway system is characterized by three basic components. These are safety indicators, safety goals and safety method.

Safety indicators are information regarding the railway system safety which allows comparing the system safety level to the safety goals. They represent parameters defining the railway safety level. Safety indicators comprise the system elements. The indicators are i.e. serious incidents, accidents where lives were lost, and others.

Based on the above mentioned indicators, the safety goals are set. Safety goal represents a minimum safety level expressed by acceptable risks which have to be reached by all elements of the railway system. The goal is to maintain the safety of the whole system via minimization of risks (5).

The European railway agency has developed a method serving a purpose of describing ways to assess the safety level, reach the safety goals and observe other requirements regarding the railway safety.

Common safety method (CSM) introduces a harmonized approach to risk evaluation, which is necessary for the integrated railway space. The integrated railway space has become one of the main priorities of the EU. It requires strict European legal decrees mostly in the area of safety requirements. CSM is used when it is necessary to assess major changes to the railway system in any member state. The outcome of the common safety method is controlling of the dangers regarding the defined change. The CSM is in use since July 1<sup>st</sup>, 2012. It is necessary to allow enough time for understanding the method, so that the affected ones may get know the new common approach. There is not standard method in Slovak Republic for assessing safety risks in railway system. It is therefore necessary to verify the usability of the common safety method.

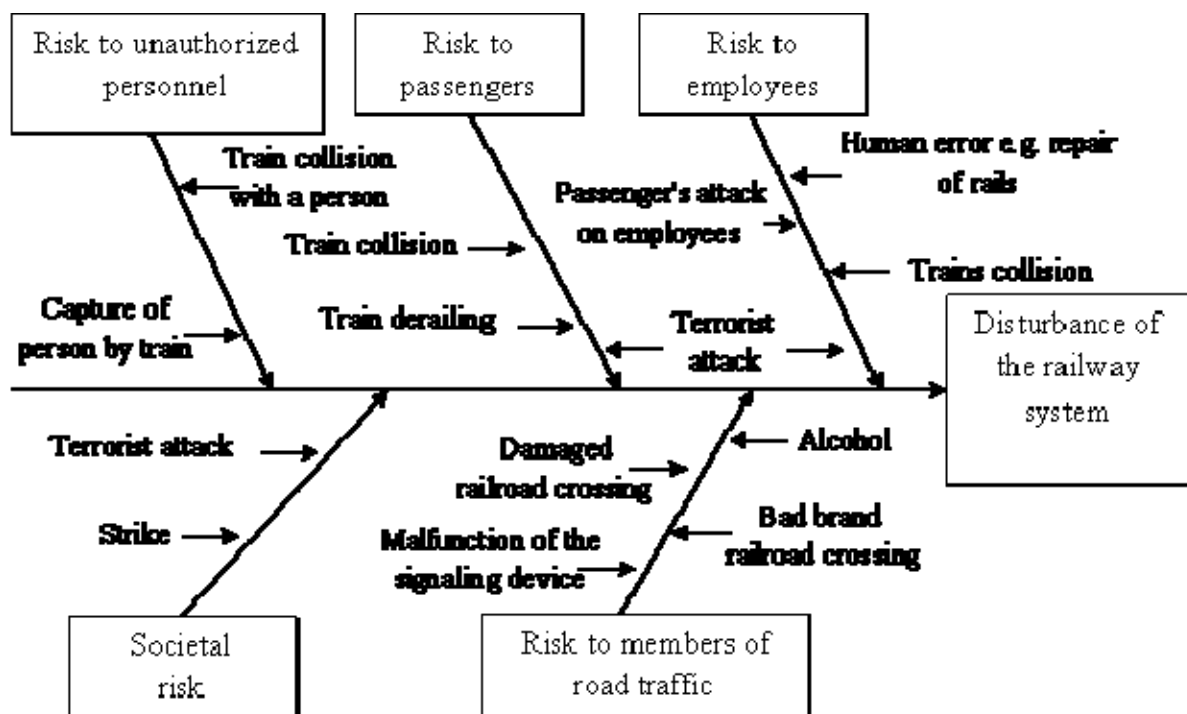
#### 4. RISK AND ITS ACCEPTABILITY IN THE RAILWAY SYSTEM

The figure 3 shows an Ishikawa diagram where on the main axis shows a problem representing a disturbance in the railway system safety. Branches of the diagram depict different influences causing the problem. Disturbance of the railway system may cause risk for:

- employees,
- passengers,
- unauthorized persons in the vicinity of the railroad tracks,
- members of the road traffic,
- society.

Each risk has various causes which are depicted on the figure as decomposition of diagram branches. Employees and passengers are regarded as a primary group affected by the risk.

Railways *employees* are people taking part in the transportation process. Employees working in i.e. the railway stations, maintenance, transitters, train drivers all fall in this category. The occurrence of risk for the employees may be caused by different events such as train crash, human error (at railroad maintenance), terrorist attack, assault by passenger and others.



Source: Authors

Fig. 3 – Causes for railway system safety breach

*Passengers* are not to be understood only as persons in the train, but also ones waiting in the railway station. Risk for the passengers may be caused by i.e. trains collision, train

derailing and/or terrorist attack. One of the main properties of the terrorist attack is to assault large number of people. Train station or railway vehicle are places with high density of people (passengers, employees and others). Other risk causes may include i.e. explosion of the reservoir with dangerous material, various injuries caused by i.e. fall from the railway vehicle.

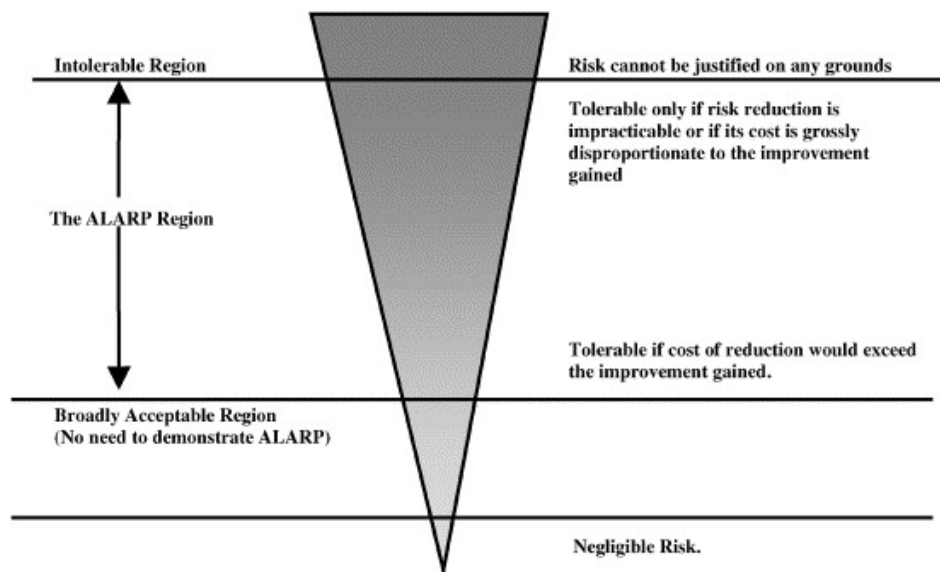
In the vicinity of the railroad tracks there may be *unauthorized personnel*. Such persons are undertaking various risks, i.e. of taking part in a train accident, direct exposure to dangerous material and others.

Collisions of trains with the *members of road traffic* at the railroad crossings are considered as a big part of the railroad accidents. Causes of such accidents include malfunction of the signaling device, damaged railroad crossing, or driving under influence of alcohol or other substances.

*Society* or collective risk may be caused by possible terrorist attack or strike.

The diagram offers a possibility of in-depth understanding of causes for risk occurrence and thus possibility of implementation of suitable remedies.

The important question regards the risk acceptability – what risk level is still acceptable. Organization and individuals have to often decide what levels of risks are considered as acceptable. However, a level of risk acceptable for one entity may not be acceptable for other entity. This shows that the risk acceptance is entirely subjective. For example, it is required by law that in Great Britain is risk to be maintained as low as reasonably practicable (ALARP)-fig.4.



Source: (1)

Fig. 4 – ALARP model

This has been declared by the British agency for health and safety. This model regards also economical point of view necessary to lower the risk. With the ALARP model it is necessary to assess residual risk and include a proof that it is not reasonably possible lower the risk any further. As shown on the figure 4, ALARP determinates three risk regions. In case the risk level reaches an unacceptable region, it is necessary to lower the risk level at

least to the next acceptable one. If the risk level is in the lowest region, it is considered to be negligible and acceptable without any further restrictions (1). However, it is necessary to check regularly whether the risk remains within the acceptable region.

Boundary between the broadly acceptable region and ALARP is considered as safe level. However, this does not necessarily imply zero risk level. Similarly, the boundary between ALARP region and intolerable region is considered as dangerous level, although it does not mean indivertible catastrophe or even maximum risk level.

The width of the triangle in the ALARP model represents the economical means needed to lower the risk. In other words: the higher the risk, the higher the required expenses for its suppression.

This does not necessarily mean that substantial risk suppression means substantial expenses. In many cases it is possible to achieve substantial risk suppression with negligible expenses.

## CONCLUSION

In each system there is possibility for its violation. It is necessary to address the problem of raising the safety of the railway system with priority on preventing serious accidents using the newest scientific and technological advances. The question of safety is very complicated, because there is no hundred percent safety, and I consider it very important to continuously monitor the required safety level of the system.

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